

# NASA TECH BRIEF



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## Single Degree of Freedom Antenna Pointing Program (ANTENA)

### The problem:

A natural consequence of the increasing scientific scope and sophistication of exploratory missions to the moon and the planets has been the demand for an increasing information-transmission capability. Consideration of the tradeoffs between spacecraft transmitter power and weight vs spacecraft antenna gain and weight, points to the use of a more directive antenna and its accompanying higher gain as the most advantageous method of improving communication system performance. However, a highly directive antenna implies a need for accurate pointing control.

### The solution:

A computer program which optimizes the accuracy of pointing a radiofrequency antenna at a target whose position is time varying but known *a priori*, with respect to a certain reference frame. The antenna is assumed to have a single degree of rotational freedom made necessary by the extent of target movement.

### How it's done:

The program employs a technique whereby the antenna is periodically rotated in discrete increments on command from an onboard sequencer. The sequencer is capable of generating a programmable series of pulses which update the antenna's position according to a preselected angular time function. Thus, the system is basically an open-loop controller which relies on an accurate, three-axis stabilization of the spacecraft with respect to certain celestial references.

Of central importance in the program is a subroutine which, given tabular data on target position-vs-time, determines an optimum location for the an-

tenna's rotation axis. The location is optimum in the sense that it minimizes the maximum pointing error over the time period of interest. A consequence of the optimization is an optimal function (angle-vs-time) for rotating the antenna so as to achieve minimum pointing error at each instant of time.

Having computed an optimal axis location and angular function for tracking the target "open-loop", the program will approximate the optimal angular function with a "best fit," using a series of connected line segments. A line segment approximation proves valuable for economical hardware mechanization (analog or digital) of a rotational drive sequencer. The approximating function is a "best fit" in the sense that it minimizes the number of line segments.

The program accepts up to 100 target-location data points and will fit up to 24 line segments to the ideal rotation function. The user may supply the rotation axis location and request a line segment fit and/or pointing error data printout (or plot). Or, the axis location may be requested without the approximating fit. Also, data from *several* target trajectories may be supplied simultaneously to obtain a best axis location, but no curve fits are generated. The user must supply error bounds for the curve fitting process. The program will also compute and plot pointing errors due to rotation axis misalignments and/or target coordinate uncertainties. However, if a plot is desired, the user must furnish the plotting routine.

### Notes:

1. This program is written in Fortran IV for use on the IBM 7094 computer.

(continued overleaf)

2. Inquiries should be made to:

COSMIC  
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Athens, Georgia 30601  
Reference: B68-10449

**Patent status:**

No patent action is contemplated by NASA.

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